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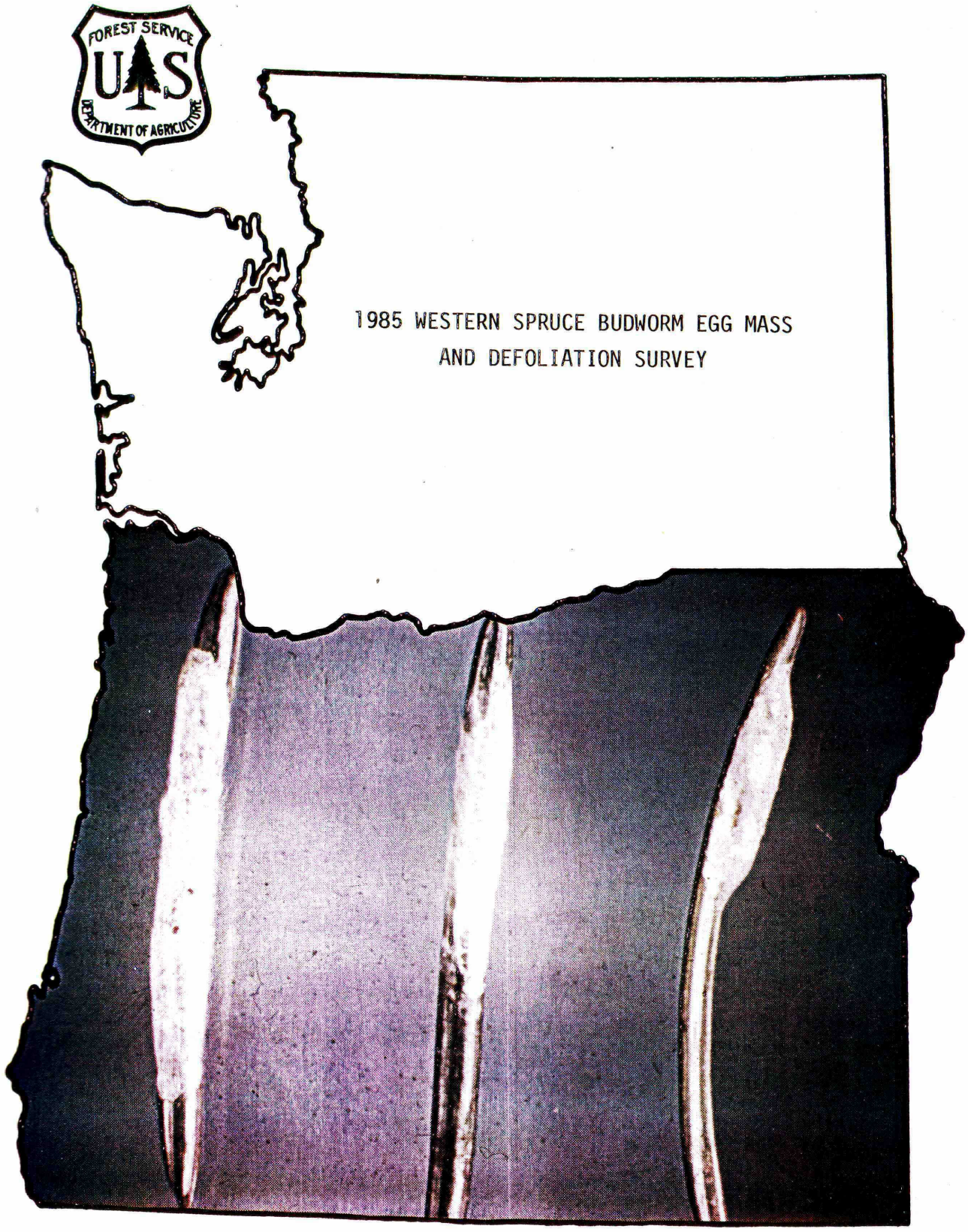
Forest Pest Management
Pacific Northwest Region



1985 WESTERN SPRUCE BUDWORM EGG MASS AND DEFOLIATION SURVEY

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Iral R. Ragenovich
Entomologist

Forest Pest Management
Pacific Northwest Region
USDA Forest Service
Portland, Oregon

INTRODUCTION

The western spruce budworm (WSBW), Choristoneura occidentalis Freeman, is currently in outbreak status in Washington and Oregon with almost 5 million acres of defoliation reported during the 1985 annual aerial detection survey.

The western spruce budworm has a 1-year life cycle. The destructive stage of the insect is the larval stage, which mines in the buds and feeds on the current year's foliage, primarily during June. As the spring and summer progress, the damaged needles turn red and the trees within the infested area take on a reddish appearance. Repeated heavy defoliation of the new growth can result in growth loss and top-kill.

The 1985 egg mass and defoliation survey was designed to obtain information on potential population densities and projected levels of defoliation in 1986 for specific areas of interest. Included in the survey were: (1) analysis units identified as having a benefit/cost ratio greater than one in the January 1985 economic analysis; (2) additional analysis units with benefit/cost ratios less than one, but were of concern to the Forest manager; and (3) some areas where new infestations had been detected during the aerial detection survey. The areas included in this evaluation are as follows:

Malheur National Forest
- Crockett, Jump-Off-Joe, Pogue 2, Dixie, Flat, King, Sawtooth, Butte, Lost Cabin, McCoy, Reynolds, Malheur, Starr, Dry Creek, Monument, and Glacier Analysis Units

Ochoco National Forest
- Cougar, Round, and Maury Analysis Units

Mt. Hood National Forest
- Hood River, Dalles, and Barlow Analysis Units

Wenatchee National Forest
- Rimrock and Naches Analysis Units

Okanogan National Forest
- Mt. Hull and Funk Mountain Analysis Units

Warm Springs Indian Reservation
- Jefferson and Wilson Analysis Units

Wallowa-Whitman National Forest
- Elkhorn, Limber Jim, Union[1/], Sumpter Watershed, Dark Canyon, and Dooley Analysis Units

Umatilla National Forest and Umatilla Indian Reservation

Deschutes National Forest

METHODS

The computer program for processing multistage sampling, MUST (Hazard and Steward, 1979), was used to determine the optimum sample size using among plot and among tree variances and costs from the 1984 data. This was a two-stage design, using plots as the first stage and trees as the second stage. The optimum sample size was 34 plots, 5 trees per plot, and one branch per tree (30 percent SE p = .90). Time, personnel, and access were restricting factors in allowing the optimum level of sampling for individual units, therefore, analysis units in close proximity to each other were combined into sample areas. The plots were then allocated to the analysis units within sample areas according to the proportion of acres each unit contributed to the area. There were no specifically identified analysis units for areas where new infestations were detected. As a result, as many plots as possible were distributed throughout the area of visible defoliation.

The sample design for all areas was the same. Each sample plot consisted of five trees. Sample trees could be either Douglas-fir or true fir; however, all sample trees in a plot had to be the same species, and were to be the predominant species of the stand. Trees were typically open grown and 7- to 14-meters tall. One 45 cm branch tip was clipped from the mid-crown of each sample tree using a pole pruner equipped with a catch basket. All branch tips from a plot were placed in a plastic bag, along with a plot data sheet. The bag was then placed in a cardboard box and kept as cool as possible until the branches could be examined in the laboratory. In the laboratory, branches were measured for exact length and width. A defoliation rating was made on each of 20 buds for the 1985 defoliation using the 6-class defoliation index system. An average defoliation rating using the 6-class index was also made on the 1984 and 1983 growth for each branch. The 6-class index key is as follows:

Index		Percent Defoliation	Index		Percent Defoliation
1	=	0	4	=	51 - 75
2	=	1 - 25	5	=	76 - 99
3	=	26 - 50	6	=	100

After each branch had been measured and the defoliation rated, it was examined for budworm egg masses. For each branch, egg masses were classified according to their occurrence on old and current year's foliage. Egg masses on old foliage were then examined under a dissecting microscope to determine whether they were old or new.

1/ Sampling restricted to the Mill Creek-Cove area.

The data was analyzed using the MUST Program to compute the mean and standard deviation for both the defoliation and egg masses. The mean number of new egg masses per square meter of foliage was calculated for each analysis unit. Based on egg mass density, a prediction of defoliation for 1986 can be made using values established by Carolin and Coulter (1972).

Egg Masses Per Sq. Meter	Defoliation Category
0 - 2.0	Very Light
2.1 - 5.4	Light
5.5 - 13.8	Moderate
13.9 - 27.4	Heavy
27.5 +	Very Heavy

RESULTS AND DISCUSSION

A total of 379 plots were sampled during the egg mass survey. Due to limiting factors, some of the sample areas have fewer than the optimum 34 plots. Table 1 summarizes the egg mass and defoliation results. The table lists each sample area and the analysis units within that area. Although the table provides egg mass density and defoliation results for individual analysis units, it should be remembered that the total combined represents the optimum sample size. If analysis units are examined individually, there will be a larger standard error due to the smaller sample size. The following is a discussion of each of the sample areas.

MALHEUR 1

This sample area consisted of the Crockett, Jump-Off-Joe, Pogue 2, Dixie, and Flat Analysis Units (Figure 1). The average egg mass density is 6.67 $\pm$ .98 egg masses per square meter of foliage. The ratio of old to new egg masses is 1:1.1, indicating that the population densities in 1986 will be similar to the 1985 levels.

The average defoliation indicies for 1983, 1984, and 1985 indicate that the intensity of the defoliation has increased each year from moderate to very heavy. Approximately 75 percent of the new foliage (index of 4.9) was defoliated by WSBW in 1983, and about 95 percent defoliation (index of 5.8) in 1985.

Based on the defoliation and egg mass information, it is expected that for 1986, WSBW populations will remain at the same level as 1985 and that the resultant defoliation will be heavy.

MALHEUR 2

The Malheur 2 sample area consisted of the King, Sawtooth, Butte, and Lost Cabin Analysis Units (Figure 2). The average egg mass density for this sample area is 11.14 $\pm$ 1.88 egg masses per square meter of foliage. The ratio of old to new egg masses is 1:4.1, indicating an increase in the WSBW population density for 1986.

Defoliation for the past 3 years has been moderate, with an average index rating of 4.5, which is comparable to about 60 percent of the new growth defoliated. Based on the high numbers of new egg masses per square meter of foliage, however, it is expected that defoliation in 1986 will be heavy.

MALHEUR 3

The Malheur 3 sample area consisted of the McCoy, Reynolds, Malheur, Monument, and Glacier Analysis Units. No plots were located in the Glacier and Monument Units due to the lack of access; however, they are bordered on three sides by the other analysis units in the sample area (Figure 1). The average egg mass density is 6.56 ± 1.50 egg masses per square meter of foliage. The ratio of old to new egg masses is 1:1.2, which indicates that the population density is expected to be similar to that in 1985. When looking at individual analysis units, populations appear to be slightly less than the previous year in the Reynolds Unit; and they appear to be increasing in the Malheur Unit, with 2.6 times more new egg masses.

Defoliation has increased over the past 3 years, with an average of 50 percent defoliation (index of 4.1) of new growth in 1983, to about 80 percent defoliation (index of 5.2) in 1985. The Malheur Analysis Unit had less defoliation, about 60 percent (index 4.4.). However, with the indicated increase in egg mass density, it is not likely that the defoliation in this unit in 1986 will differ significantly from the other units in the sample area. Defoliation is expected to be heavy throughout most of this sample area in 1986.

MALHEUR 4

This sample area consisted of the Dry Creek and Starr Analysis Units (Figure 1). The average egg mass density is 10.75 ± 1.95 egg masses per square meter of foliage. The ratio of old to new egg masses is 1:1.5, which indicates a population density similar to that in 1985. Egg mass densities and defoliation have been similar for both areas for the past 3 years. The amount of defoliation each year has increased from about 66 percent defoliation (index of 4.8) in 1983, to about 90 percent (index of 5.6) in 1985. Based on the fairly high numbers of egg masses found in these areas, defoliation should be heavy again in 1986.

OCHOCO

The analysis units in this sample area were Cougar, Round, and Maury (Figure 3). The average number of egg masses per square meter of foliage is 9.28 ± 1.76. Based on the ratio of old to new egg masses, 1:1.5, the population will be about the same density in 1986 as it was in 1985.

The average percent defoliation shows that the amount of defoliation has increased from about 72 percent (index of 4.8) defoliation in 1983 to about 95 percent defoliation (index of 5.8) in 1985. Defoliation is expected to be heavy again in 1986.

MT. HOOD

The Hood River, The Dalles, and Barlow Analysis Units are in this sample area (Figure 4). The average egg mass density for the area is 7.25 ± 1.51 egg masses per square meter of foliage. However, when looked at individually, the

egg mass density on the Hood River Analysis Unit is lower than in either The Dalles or Barlow Units. The ratio of old to new egg masses indicates an average three-fold increase for the sample area. The ratios for individual units are 1:5.7, 1:1.8, and 1:8.3 for the Hood River, The Dalles, and Barlow Analysis Units, respectively.

The average defoliation was low for 1983 and 1984, with about 12 percent (index of 2.1) in 1983, and about 23 percent (index of 2.7) in 1984. Defoliation in 1985 was moderate, about 55 percent (index 4.3). Individually, defoliation on the Dalles and Barlow Analysis Units in 1985 were 85 (index of 5.5) and 68 percent (index of 4.6), respectively. Defoliation remained low at 2.7, or about 20 percent, on the Hood River Analysis Unit.

Based on the numbers of egg masses and the increase in populations, it is expected that defoliation will be moderate to heavy on the Dalles and Barlow Analysis Units, and moderate on the Hood River Analysis Unit.

WENATCHEE

The Rimrock and Naches Analysis Units are in this sample area. Plots were distributed throughout both units; however, no egg masses were found on plots north of T. 15 N. on the Naches Unit (Figure 5); therefore, the results of the analysis pertain only to Rimrock and that portion of the Naches Analysis Unit south of T. 15 N. The average egg mass density for this area was 7.84 ± 2.81 egg masses per square meter of foliage. The ratio of old to new egg masses was 1:3.9, indicating the population is still increasing.

how many?

Defoliation has increased from about 10 percent (index of 2.1) in 1983 to about 45 percent (index of 3.7) in 1985.

Based on the numbers of egg masses, it is expected that defoliation will be moderate to heavy in 1986.

WARM SPRINGS

The Jefferson and Wilson Analysis Units comprise the Warm Springs sample area (Figure 4). The average egg mass density is 11.07 ± 2.02 egg masses per square meter of foliage. The ratio of old to new egg masses is 1:3.4.

Defoliation has been increasing in intensity from about 20 percent (index of 2.6) in 1983 to about 80 percent (index of 5.3) in 1985.

Based on the number of egg masses per square meter of foliage, defoliation can be expected to be heavy in 1986.

WALLOWA-WHITMAN

This sample area consists of the Elkhorn, Limber Jim, Union, Sumpter Watershed, Dark Canyon, and Dooley Analysis Units (Figure 6). The average egg mass density is 14.75 ± 1.93 egg masses per square meter of foliage. The ratio of old to new egg masses is 1:2.7. Egg mass densities were highest in the Dark Canyon, Dooley, Limber Jim, and Elkhorn Analysis Units.

The average 1985 defoliation was 5.3 or about 80 percent (index of 5.3). This was an increase from an average of 65 percent (index of 4.5) in 1984 and about 52 percent (index of 4.1) in 1983. It is expected that defoliation will again be heavy throughout the Units in 1986.

UMATILLA

This sample area consists of that portion of the Umatilla National Forest north of Interstate Highway 84 and the forested lands on the Umatilla Indian Reservation. This is a new infestation area where visible defoliation has only been detected recently. The average egg mass density is 15.73 ± 3.17. The ratio of old to new egg masses was 1:10.7, a significant increase from the previous year.

Defoliation in 1983 and 1984 was light. In 1985, the defoliation was about 53 percent (index 4.1). Based on the large increase in population levels, defoliation can be expected to be moderate to heavy in 1986.

DESCHUTES

The infestation on the Deschutes National Forest is also a new infestation. The egg mass density is 8.03 ± 1.49 egg masses per square meter of foliage. The ratio of old to new egg masses is 1:4.1.

In 1983, defoliation was very light (index of 1.9). In 1984, it was about 8 percent defoliation (index of 2.3); and in 1985, it was about 60 percent defoliation (index 4.6). Based on the number of egg masses, defoliation is expected to be moderate in 1986.

OKANOGAN

The Analysis Units for the Okanogan sample area were Funk and Mt. Hull (Figure 7). The Washington Department of Natural Resources conducted the sampling and did the analysis of this area, consequently, the data for this sample area were not computed through the MUST Program. The average egg mass density is 17.2 egg masses per square meter of foliage. The ratio of old to new egg masses is 1:10.2.

Defoliation was assigned a class of light, moderate, or heavy. For the purposes of this report, the classes were assigned an index. The average 1985 defoliation for the sample area was moderate; however, defoliation was heavier on the Mt. Hull Analysis Unit.

Based on the defoliation and egg mass densities, the western spruce budworm population in the Okanogan area is increasing. With ten times as many new egg masses as old, it is expected that there will be moderate to heavy defoliation in 1986.

CONCLUSION

Based on the results of the 1985 western spruce budworm egg mass survey, there is no evidence to indicate that the budworm populations are declining. The ratio of old to new egg masses denote the population continues to increase in most areas. In addition, the average number of egg masses per square meter of foliage as measured in all sample areas remain at a level to cause visible defoliation in 1986. Growth loss and topkill will continue to increase, and in the older outbreak areas some tree mortality will probably begin to occur.

1/Number in parenthesis is number of sample plots for each area.

Table 1. Results of the 1985 Egg Mass and Defoliation Survey (continued).

Sample Area/AU	Egg Mass Density$_2$ New Egg Masses/m^2	Ratio (old:new)	Avg. Defoliation Index 1983	1984	1985
MT. HOOD					
Hood River (13)	3.87 ± 1.75	1:5.7	1.4	1.8	2.7
Dalles (15)	9.24 ± 2.36	1:1.8	2.8	3.6	5.5
Barlow (14)	8.26 ± 3.35	1:8.3	1.9	2.6	4.6.
Total Combined (42)	7.25 ± 1.51	1:3.1	2.1	2.7	4.3
WENATCHEE					
Rimrock (8)	9.72 ± 5.55	1:4.0	2.1	2.3	4.0
Naches (8)	5.95 ± 1.91	1:3.9	2.1	2.1	3.3
Total Combined (16)	7.84 ± 2.81	1:3.9	2.1	2.2	3.7
WARM SPRINGS					
Jefferson (7)	16.97 ± 4.33	1:5.0	2.8	3.6	5.1
Wilson (20)	9.00 ± 2.14	1:2.7	2.5	3.5	5.4
Total Combined (27)	11.07 ± 2.02	1:3.4	2.6	3.5	5.3
WALLOWA-WHITMAN					
Elkhorn (15)	13.39 ± 4.68	1:1.7	4.3	5.0	5.5
Limber Jim (10)	13.99 ± 5.27	1:2.4	3.6	4.0	5.4
Union (12)	7.49 ± 1.42	1:2.9	3.9	4.8	5.3
Sumpter W.S. (3) 2/	7.28 ± 2.44	1:2.9	3.1	4.7	6.0
Dark Canyon (9)	24.43 ± 6.41	1:4.7	3.0	3.4	5.0
Dooley (15)	17.62 ± 3.41	1:3.1	4.9	4.9	5.1
Total Combined (63)	14.75 ± 1.93	1:2.7	4.1	4.5	5.3

2/ Sumpter W.S. qualified with a positive B/C ratio in 1/85 economic analysis.

Table 1. Results of the 1985 Egg Mass and Defoliation Survey.

Sample Area/AU	Egg Mass Density New Egg Masses/m^2	Ratio (old:new)	Defoliation Index Avg. 1983	1984	1985
MALHEUR 1					
Crockett (5)1/	5.75 ± 1.06	1:1.1	4.8	5.0	5.8
Jump-Off-Joe (3)	5.44 ± 3.01	1:3.4	3.2	4.1	5.5
Pogue 2 (3)	11.05 ± 3.18	1:1.3	4.4	5.2	5.7
Dixie (3)	2.02 ± 1.11	1:1.4	5.4	5.8	5.9
Flat (17)	8.02 ± 1.59	1:1.0	5.2	5.7	5.8
Total Combined (34)	6.67 ± .98	1:1.1	4.9	5.4	5.8
MALHEUR 2					
King (4)	2.30 ± .77	1:4.2	4.8	3.9	5.5
Sawtooth(4)	15.82 ± 9.62	1:4.9	4.4	4.7	3.9
Butte(2)	7.56 ± 7.56	1:3.9	4.8	4.8	4.6
Lost Cabin (29)	11.96 ± 2.10	1:4.0	4.4	4.8	4.5
Total Combined (39)	11.14 ± 1.88	1:4.1	4.5	4.7	4.5
MALHEUR 3					
McCoy (8)	11.40 ± .50	1:1.1	4.4	5.3	5.6
Reynolds (5)	1.49 ± .62	1:0.7	4.1	5.2	5.9
Malheur (7)	4.64 ± 1.93	1:2.6	3.7	4.5	4.4
Total Combined (20)	6.56 ± 1.50	1:1.2	4.1	5.0	5.2
MALHEUR 4					
Starr (14)	11.32 ± 3.11	1:1.4	5.2	5.5	5.6
Dry Creek (14)	10.19 ± 2.47	1:1.6	4.5	4.6	5.6
Total Combined (28)	10.75 ± 1.95	1:1.5	4.8	5.1	5.6
OCHOCO					
Cougar (18)	7.45 ± 1.90	1:1.2	4.8	5.5	5.9
Round (13)	10.67 ± 2.90	1:1.7	5.1	5.8	5.9
Maury (3)	14.21 ±12.36	1:1.8	3.9	5.0	5.2
Total Combined (34)	9.28 ± 1.76	1:1.5	4.8	5.6	5.8

1/Number in parenthesis is number of sample plots for each area.

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Sample Area/AU	Egg Mass Density$_2$ New Egg Masses/m^2	Ratio (old:new)	Avg. Defoliation Index 1983	1984	1985
OKANOGAN 3/			1983-1984		1985
Funk (28)	15.2	1:9.5	2.2		3.6
Mt. Hull (6)	26.5	:10.2	3.8		4.9
Total Combined (34)	17.2	1:9.5	2.4		3.8
UMATILLA (20)	15.73 ± 3.17	1:10.7	2.5	2.9	4.1
DESCHUTES (30)	8.03 ± 1.49	1:4.1	1.9	2.3	4.6

3/ Sampled by the Washington State Dept. of Natural Resources. Data were not analyzed with the MUST Program.

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1972. Sampling populations of western spruce budworm and predicting defoliation in eastern Oregon. USDA Forest Service, PNW Station, Research Paper PNW 149. 33 p.

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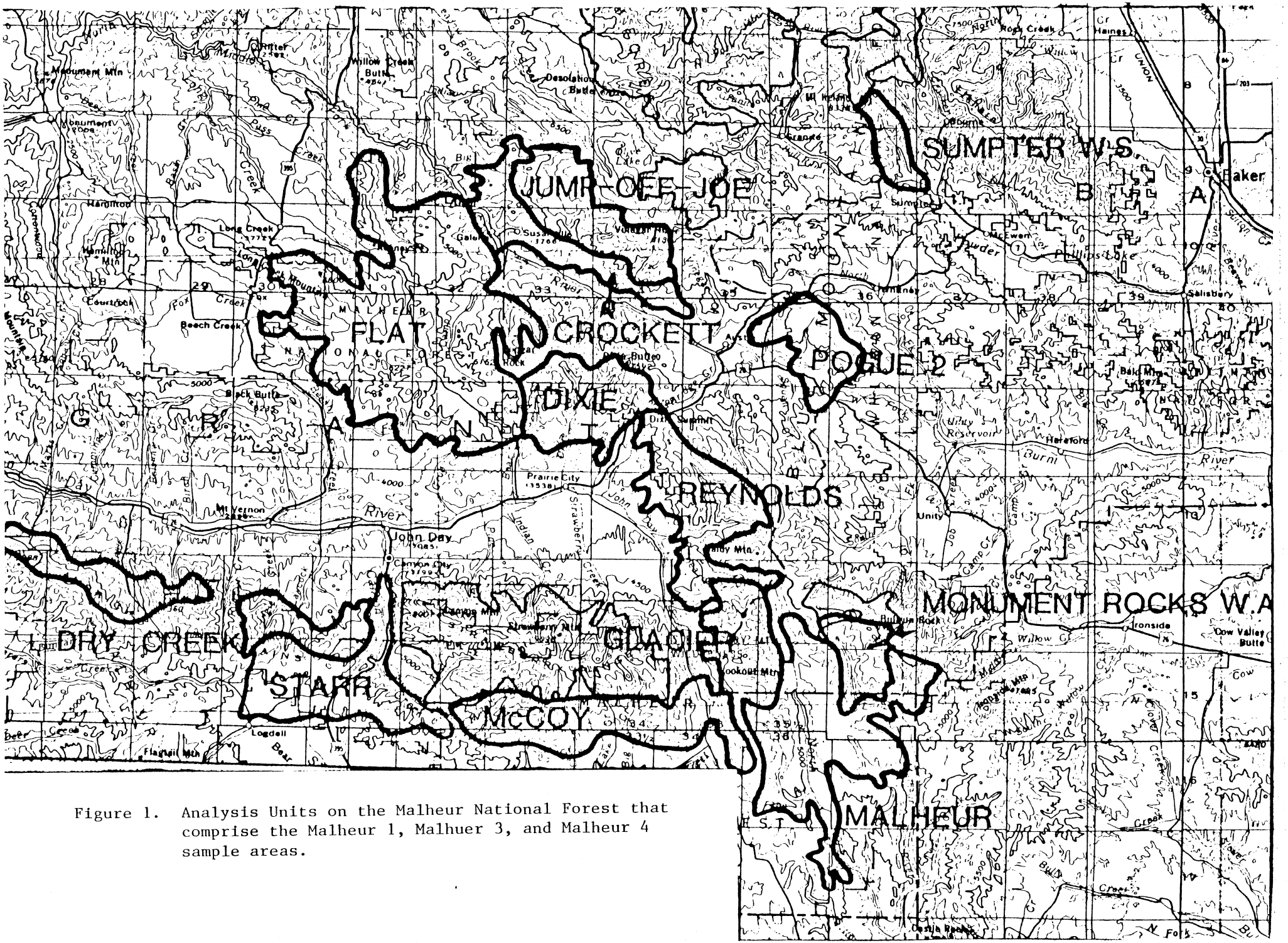
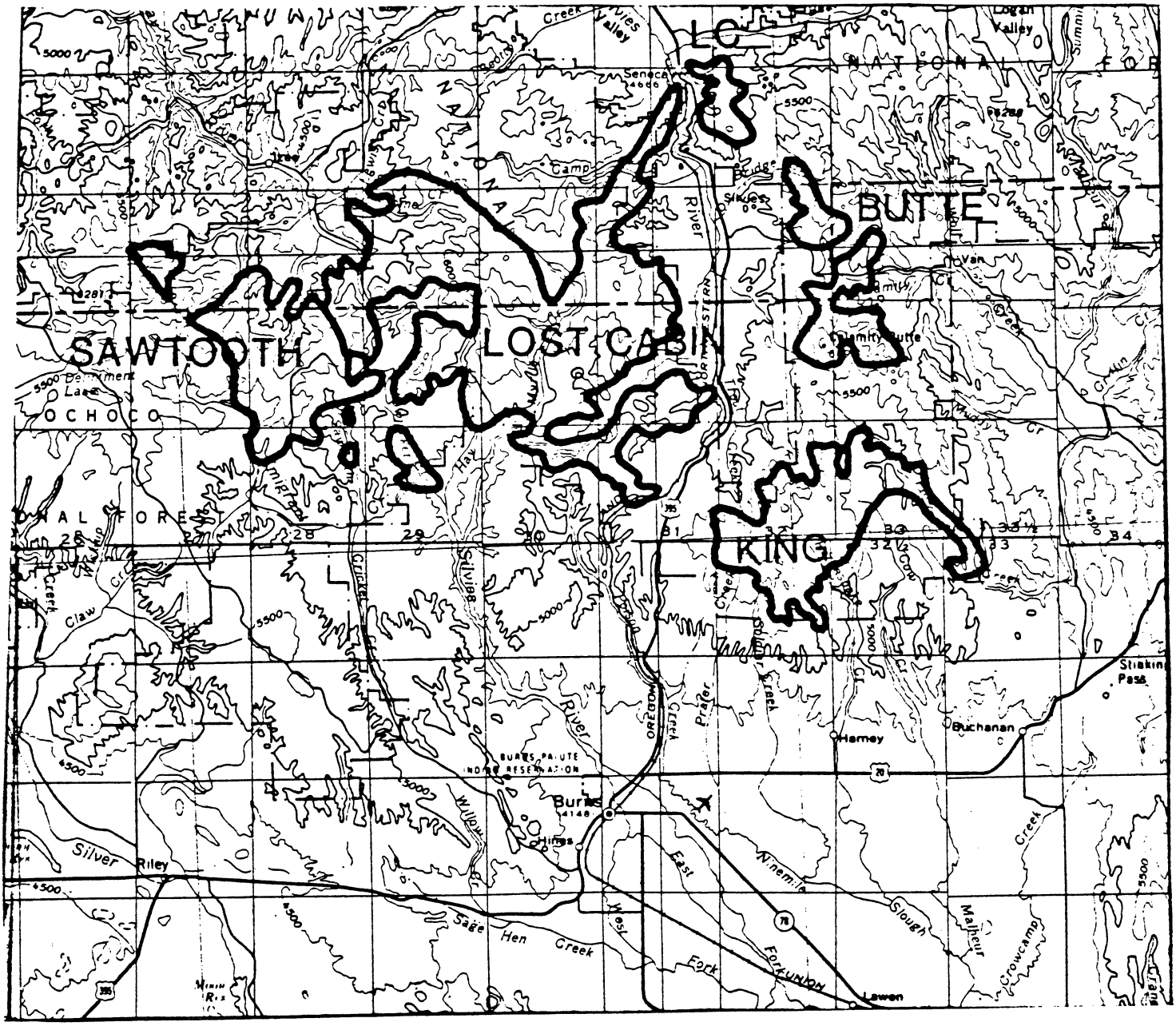


Figure 1. Analysis Units on the Malheur National Forest that comprise the Malheur 1, Malhuer 3, and Malheur 4 sample areas.

Figure 2. Analysis Units on the Malheur National Forest that are included in the Malheur 2 sample area.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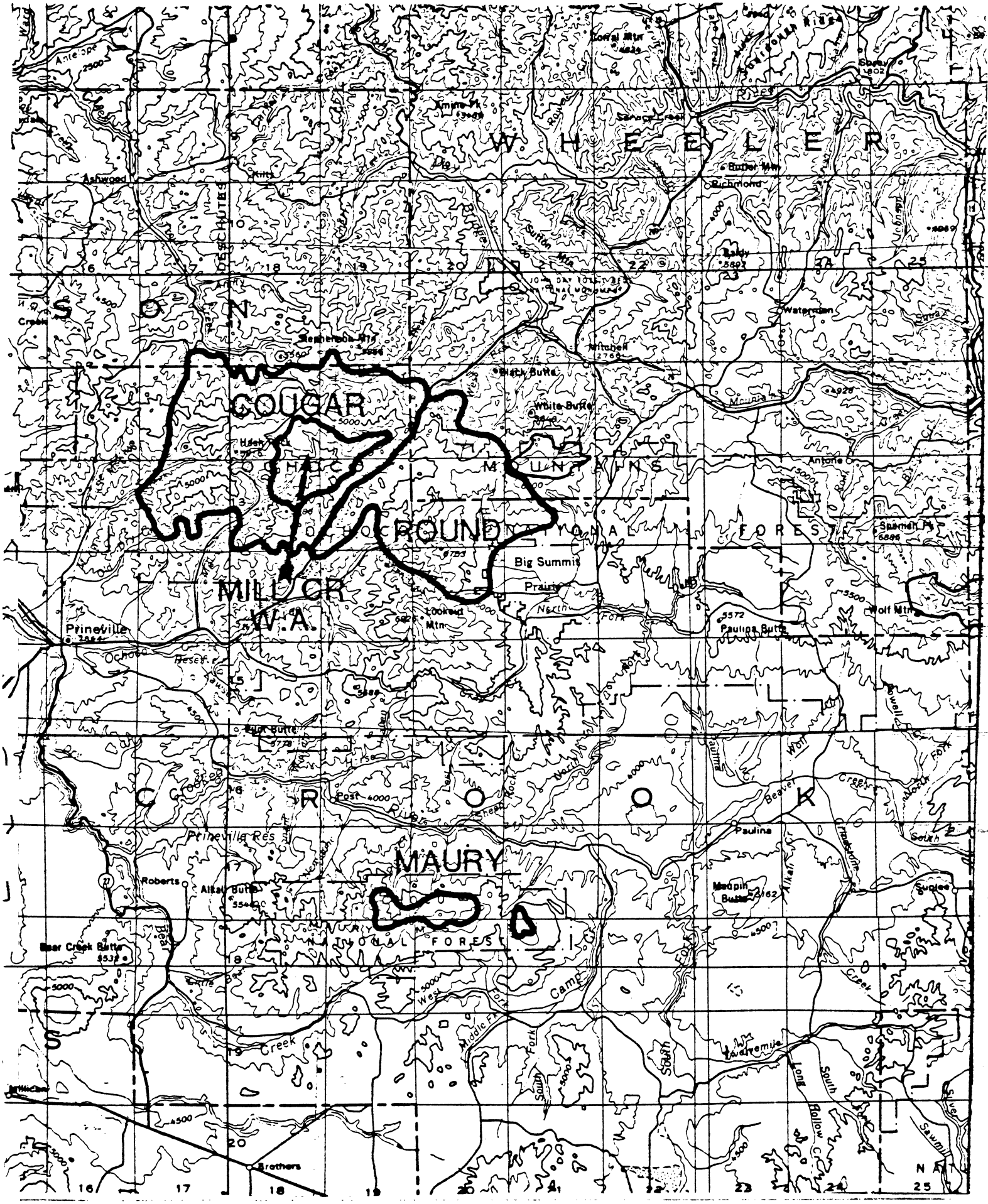

Figure 3. Analysis Units on the Ochoco National Forest

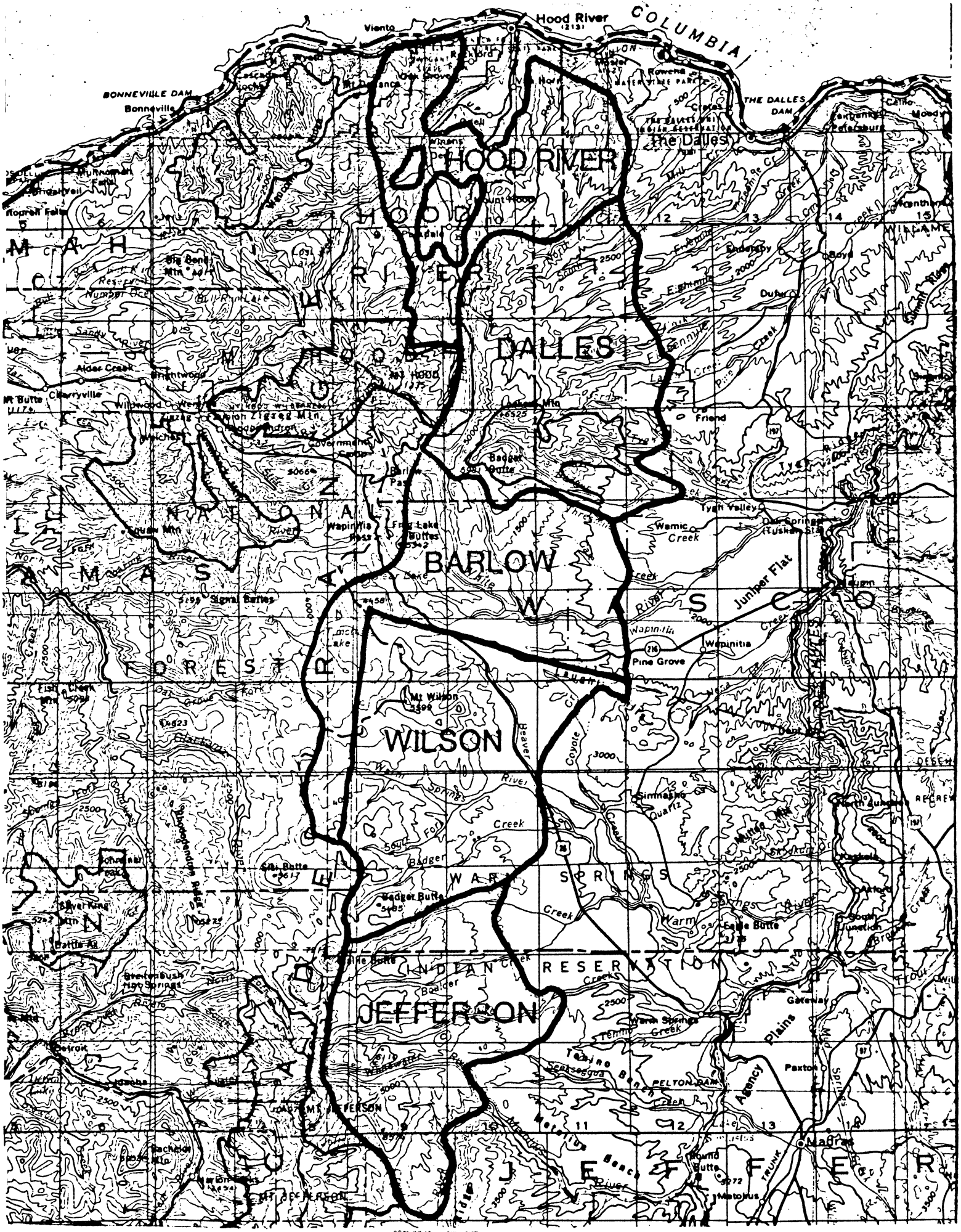

Figure 4. Analysis Units on the Mt. Hood National Forest and Warm Springs Indian Reservation.

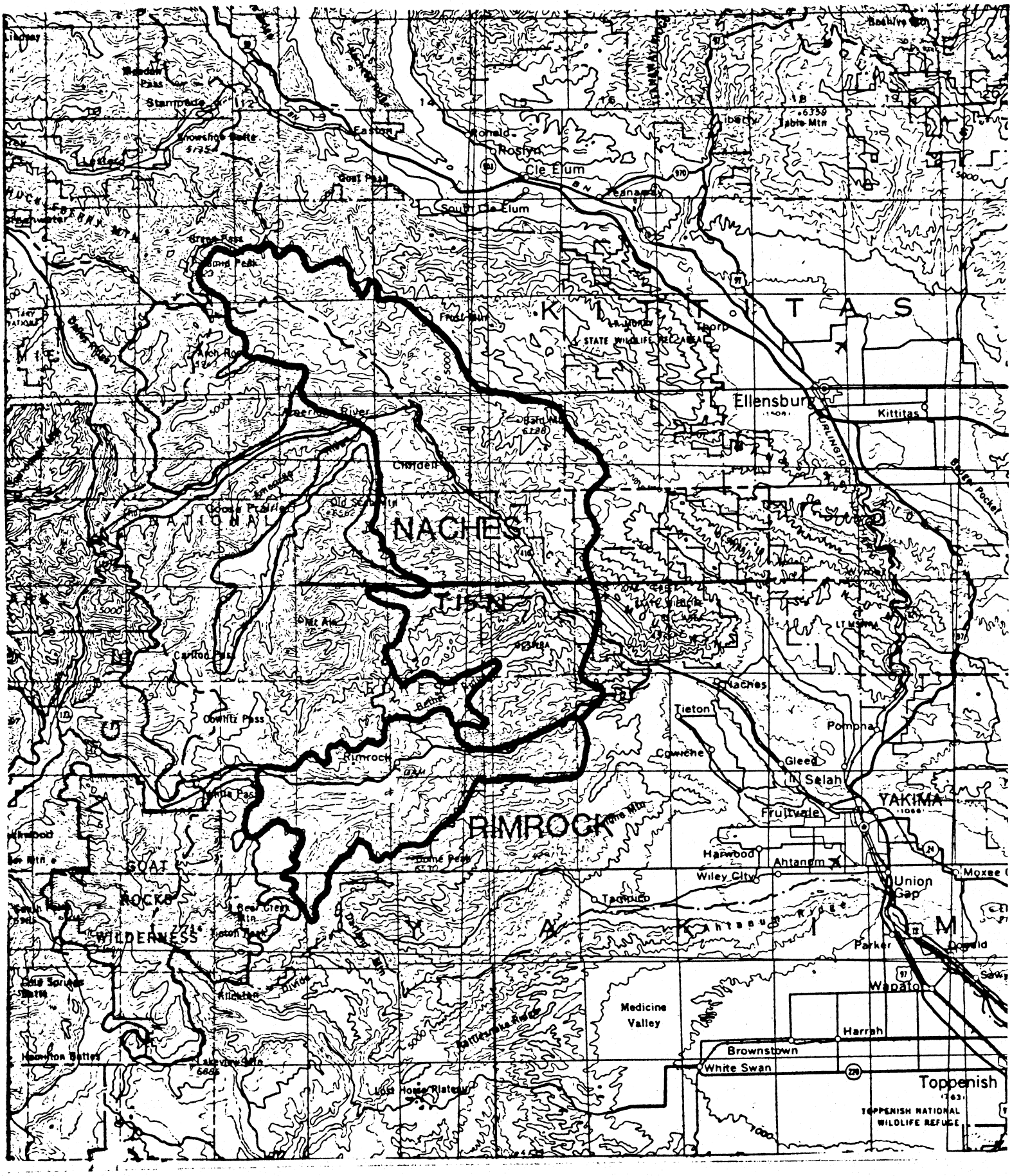

Figure 5. Analysis Units on the Wenatchee National Forest.

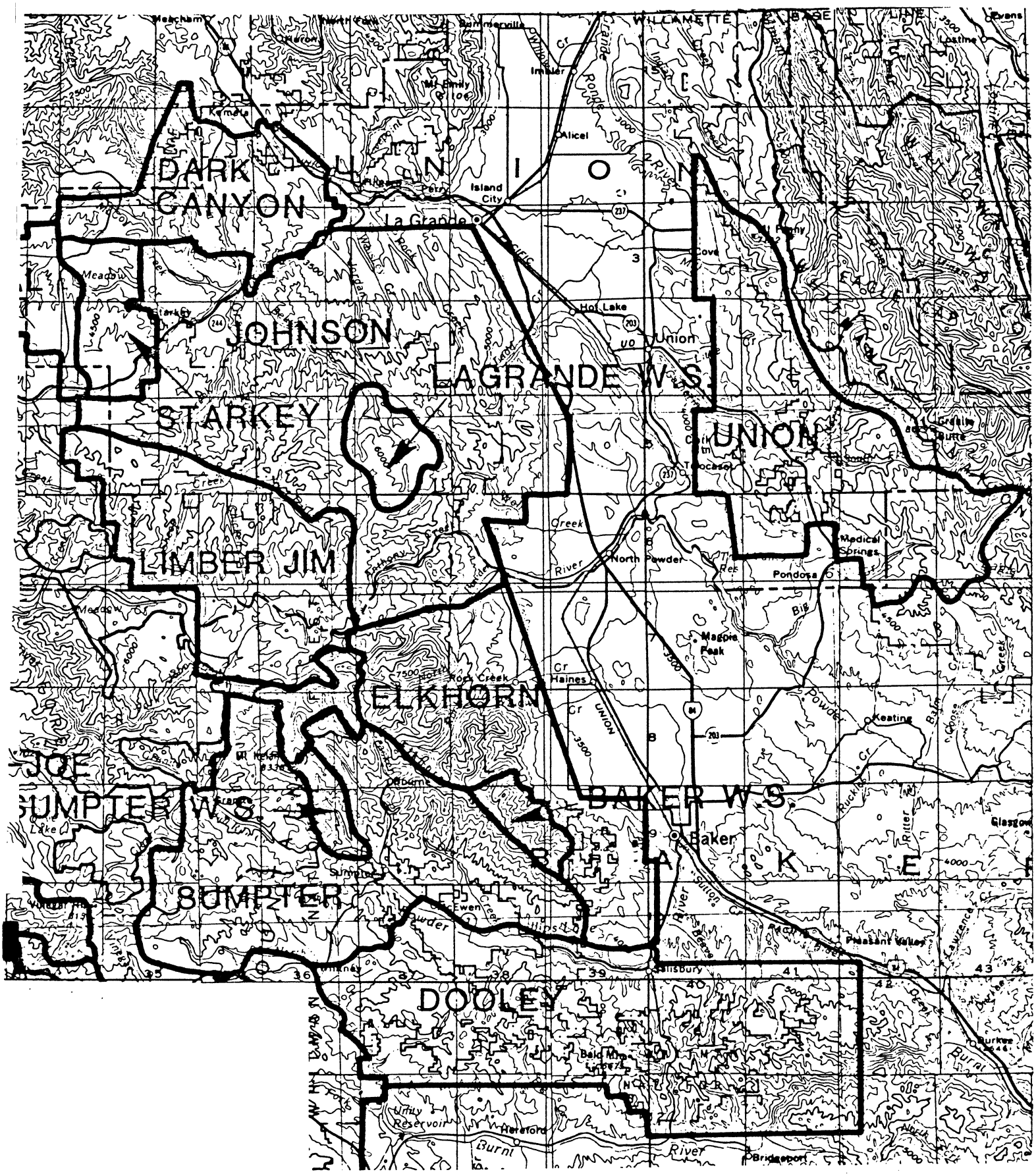

Figure 6. Analysis Units on the Wallowa-Whitman National Forest

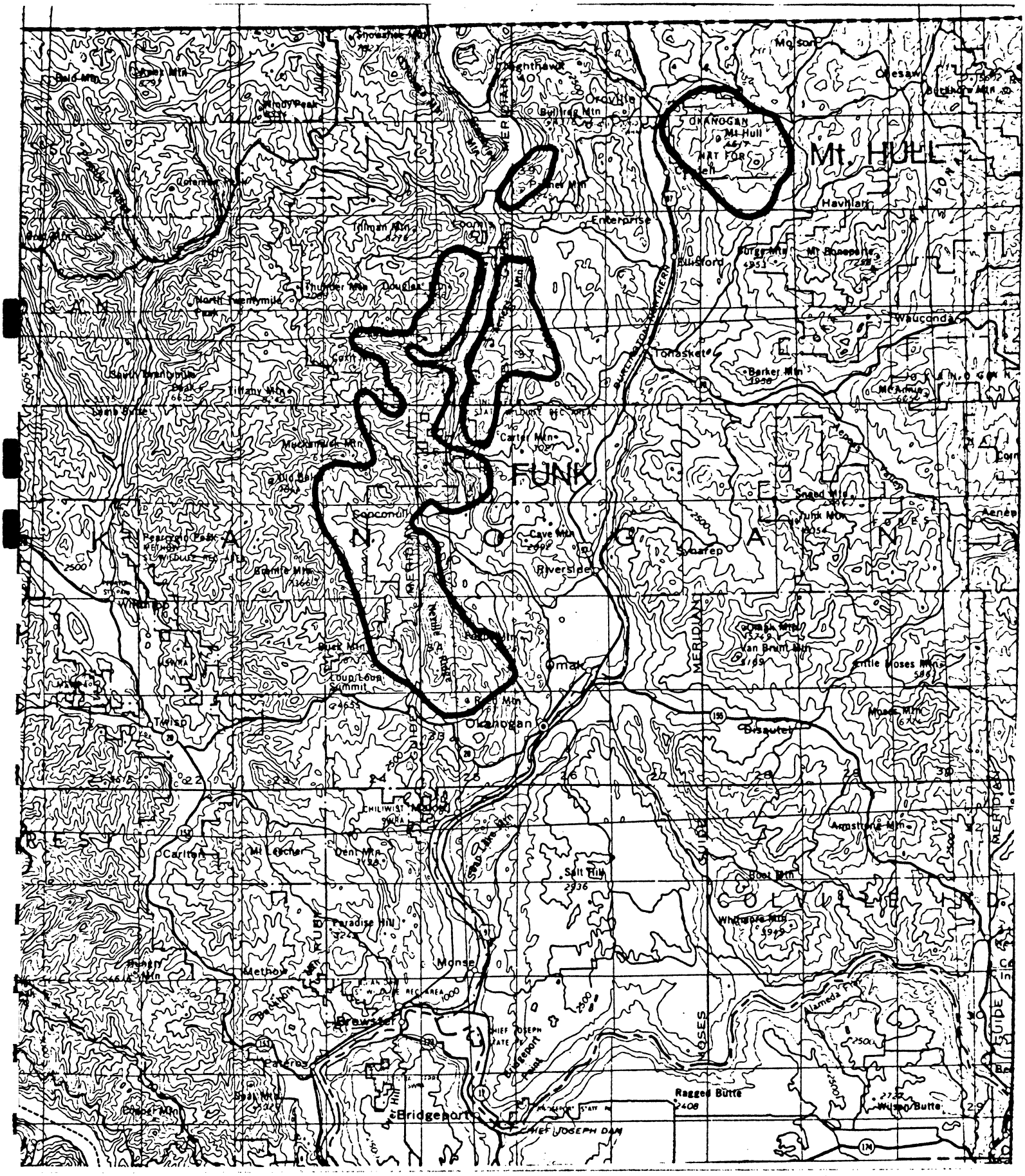

Figure 7. Analysis Units on the Okanogan National Forest.

Prepared by: _____ 1/16/86
IRAL R. RAGENOVICH, Entomologist — Date

Reviewed by: _____ 1/16/86
ROBERT E. DOLPH, Supervisory Entomologist — Date

Approved by: _____ 1/16/86
PAUL E. BUFFAM, Director, Forest Pest Management — Date